

Remarks

Support for the above-requested amendments to claims 1 and 27 is found at least in paragraphs [0021] and [0022]. Support for newly added claim 37 is found at least in paragraphs [0020], [0029], and claim 15 as originally presented. Claims 2, 3, 4, 7, and 12 have been amended to conform to the language of claim 1. Claim 5 has been amended to change the dependency of the claim. Claims 29 and 30 have been amended to conform to the language of claim 27. New claim 38 is supported at least by paragraph [0011]. Support for new claim 39 is found at least in claim 17 as originally presented. New claims 39 and 40 are supported at least by paragraphs [0021] and [0022]. Claims 28 and 33 have been canceled without prejudice. Claims 9 and 16-26 were canceled in previous Amendments. No question of new matter arises and entry of the above-requested amendments is respectfully requested.

Claims 1-8, 10-15, 27, 29-32, and 34-41 are before the Examiner for consideration.

Objection to Claims 10, 11, and 13

Claims 10, 11, and 13 have been objected to under 37 C.F.R. §1.75(c) for failing to further limit the subject matter of a previous claim. In particular, the Examiner asserts that claims 10, 11, and 13 recite “the nano-particles” but claim 1 recites “the nano-particle nucleating agents”. The Examiner states that claims 10, 11, and 13 must be amended to match the language of claim 1.

In response to this objection, Applicants have amended claims 10, 11, and 13 to recite “the nano-particle nucleating agents” as required by the Examiner. In view of the above, Applicants respectfully request that this objection be reconsidered and withdrawn.

Rejection of Claim 28 under 35 U.S.C. §112, second paragraph

Claim 28 has been rejected under 35 U.S.C. §112, second paragraph, as being indefinite. In particular, the Examiner asserts that the feature of claim 28 which recites “several tens of microns to several hundred microns” is unclear.

In response to this rejection, Applicants have canceled claim 28. Accordingly, Applicants respectfully request reconsideration and withdrawal of this rejection.

Rejection of Claims 27-36 under 35 U.S.C. §103(a)

Claims 27-36 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,759,446 to Lee, *et al.* (“Lee”) in view of Fukushima, *Graphite*

Nanoplatelets as Multifunctional Reinforcements of Polymer Composites, (“Fukushima”). In particular, the Examiner asserts that Lee teaches a process for producing a foam product that includes incorporating a nanocomposite, such as a clay, into polystyrene, incorporating a blowing agent under a first pressure and temperature, and extruding the melt under a second pressure and temperature to produce a foam having a cell size of less than about 20 microns. The Examiner admits that Lee does not teach the use of a nano-graphite as claimed.

In this regard, Fukushima is cited for assertedly teaching a method where graphite nanoplatelets are employed as a replacement for nanoclays. The Examiner concludes that it would have been obvious to one of skill in the art to modify the method of Lee to employ nano-graphite for the purpose of realizing desired product properties and while employing a material that is disclosed by Fukushima as being suited for “the same nanoreinforcement concept”.

Applicants’ Response

Initially, Applicants submit that claims 28 and 33 have been canceled without prejudice, thereby rendering the rejection of these claims moot.

In response to the rejection of the remaining claims, Applicants respectfully direct the Examiner’s attention to independent claim 27 and submit that claim 27 defines a method of making a rigid foam product that is not taught or suggested within Lee and Fukushima. Additionally, Applicants respectfully submit that Lee and Fukushima do not teach or suggest the combination of features recited in claim 27.

In particular, Applicants submit that Lee does not teach or suggest a method of manufacturing a rigid foam board or rigid foam product that includes incorporating a blowing agent into the polymer melt under a first pressure and at a first temperature and extruding the polymer melt under a second pressure and at a second temperature, where the second pressure and second temperature are sufficient to allow the polymer melt to expand and form a foam. Lee teaches forming a foamed product utilizing a two-stage single screw extruder having a custom made 10 mm length nozzle to generate a high and rapid pressure drop. (*See, e.g.* column 6, lines 11-19). The carbon dioxide is compressed to a certain pressure in a syringe pump at 40 °C to reach a supercritical state. (*See, e.g.* column 6, lines 20-31). The supercritical carbon dioxide is then injected into the barrel and mixed with the styrene melt by screw rotation. (*Id.*). Lee specifically teaches that nucleation occurs in the die because of the solubility reduction due to the quick and large pressure drop caused by the custom made

narrow capillary nozzle. (*Id.*). The foamed extrudate then flows freely into the air and vitrifies. (*Id.*).

Applicants respectfully submit that the method claimed in claim 27 is neither taught nor suggested by Lee. In the method of claim 27, the blowing agent is incorporated into the polymer melt at a first pressure and first temperature and extruded under a second temperature and second pressure, where the second temperature and second pressure allow the polymer melt to expand and form a foam. In contrast, in Lee, the foam is formed due to the supercritical carbon dioxide and the solubility reduction due to the pressure drop caused by the custom made nozzle. Applicants respectfully submit that this is vastly different from the inventive method. Accordingly, it is respectfully submitted that there is no teaching or suggestion in Lee of the combination of a first and second temperature and a first and second pressure to form a foam as is claimed in claim 27. Fukushima is silent regarding the claimed method, and as such, cannot make up for the deficiencies of Lee. Thus, Applicants submit that the combination of Lee and Fukushima would not result in the method of claim 27. Accordingly, Applicants respectfully submit that independent claim 27 defines a method for manufacturing a rigid foam product that is not disclosed or suggested within Lee. Thus, Applicants respectfully submit that claim 27 is non-obvious and patentable over Lee and Fukushima.

Additionally, Applicants submit that there is no motivation for one of skill in the art to arrive at the method of claim 27 based on the disclosures of Lee and Fukushima. To establish a *prima facie* case of obviousness, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings, and the prior art reference (or references when combined) must teach or suggest all the claim limitations. (*See, e.g., Manual of Patent Examining Procedure*, Patent Publishing, LLC, Eighth Ed., Rev. 7, August 2008, §2143 citing *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 82 USPQ2d 1385 (2007)).

Applicants respectfully submit that one of skill in the art would have no motivation to arrive at a method of manufacturing a rigid foam product that includes incorporating the blowing agent into the polymer melt at a first pressure and first temperature and extruding under a second temperature and second pressure, where the second temperature and second pressure allow the polymer melt to expand and form a foam based on the teachings of Lee and Fukushima at least because the foam of Lee is formed due to the supercritical carbon

dioxide and the solubility reduction due to the pressure drop caused by the custom made nozzle. Indeed, it is respectfully submitted that Lee is silent regarding any teaching or suggestion of a method where the second temperature and second pressure allow the polymer melt to expand and form a foam as required by claim 27. Applicants respectfully submit that without some teaching or suggestion, there can be no motivation, and without motivation, there can be no *prima facie* case of obviousness.

In addition, Applicants submit that because Lee and Fukushima do not teach or suggest a method of manufacturing a rigid foam product that includes incorporating a blowing agent into the polymer melt under a first pressure and at a first temperature and extruding the polymer melt under a second pressure and at a second temperature, where the second pressure and second temperature are sufficient to allow the polymer melt to expand and form a foam, Lee and Fukushima, alone or in combination, fail to teach all of the claim limitations set forth in claim 27. Therefore, it is respectfully submitted that a *prima facie* case of obviousness has not been established for this additional reason.

Also, Applicants respectfully submit that newly added claim 37 is separately patentable over Lee and Fukushima. Lee teaches that by controlling the carbon dioxide content, the melt and die temperatures, and pressure drop rate, a microcellular foam is formed that has a very high cell density (*i.e.*, $>10^9$ cells/cm³) and a small cell size (*i.e.*, $< 5 \mu\text{m}$). (*See, e.g.*, Abstract). It is preferred that the average cell size is less than $20 \mu\text{m}$. (*See, e.g.*, column 3, lines 30-33 and column 4, lines 24-27). Applicants respectfully submit that there is no teaching or suggestion within Lee of a method of making a rigid foam product that has an average cell size from between 60 and $120 \mu\text{m}$ as claimed in claim 37. Applicants submit that because Lee does not teach or suggest a method of making a rigid foam board having an average cell size as claimed in claim 37, claim 37 is non-obvious and patentable.

With respect to claims 29-32 and 34-36, Applicants submit that because independent claim 27 is not taught or suggested by Lee and Fukushima and claims 29-32 and 34-36 are dependent upon claim 27 and contain the same elements as claim 27, dependent claims 29-32 and 34-36 are also not taught or suggested by Lee and Fukushima.

In light of the above, Applicants submit that claims 27, 29-32, and 34-36 are not obvious over Lee in view of Fukushima and respectfully request that this rejection be reconsidered and withdrawn.

Rejection of Claims 1-8, 10-15, and 27-36 under 35 U.S.C. §103(a)

Claims 1-8, 10-15, and 27-36 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,355,341 to Chaudhary, *et al.* (“Chaudhary”) in view of Fukushima, *Graphite Nanoplatelets as Multifunctional Reinforcements of Polymer Composites* (“Fukushima”), Chen, *et al.*, *Dispersion of Nanosheets in a Polymer Matrix and the Conducting Property of the Nanocomposites* (“Chen”), U.S. Patent No. 7,071,258 to Jang, *et al.* (“Jang”) or U.S. Patent No. 5,010,112 to Glicksman, *et al.* (“Glicksman”). The Examiner asserts that Chaudhary teaches a process for producing a foam that includes blending molten polystyrene and a blowing agent and extruding the mixture through a die to form the foam product. It is asserted that the foam employs various fillers and suggests additives such as graphite. The Examiner admits that Chaudhary does not disclose the particle size of the graphite.

In this regard, Fukushima is cited for assertedly teaching a method where graphite nanoplatelets are employed as a replacement of nanoclays. Chen assertedly teaches that graphite in the form of a nanosheet is effective for improving the mechanical properties of the polymer matrix. It is also asserted that Jang teaches that graphite in the form of nano-scaled plates is suited for use in polymeric matrix materials. Further, the Examiner cites Glicksman for assertedly teaching flakes coated with a thin layer/sheet of graphite having a thickness of one or more orders of magnitude less than a micron is effective at improving the properties of a foam material. The Examiner concludes that it would have been obvious to one of skill in the art to utilize the graphite material of any one of Fukushima, Chen, Jang, or Glicksman in the process of Chaudhary to reinforce and improve the properties of the final product.

Applicants’ Response

Initially, Applicants submit that claims 28 and 33 have been canceled without prejudice, thereby rendering the rejection of these claims moot.

In response to the rejection of the remaining claims, Applicants respectfully direct the Examiner’s attention to independent claims 1 and 27 and submit that claim 1 defines a method of making a rigid foam board and claim 27 defines a method of making a rigid foam product that are not taught or suggested within Chaudhary, Fukushima, Chen, Jang, or Glicksman. Additionally, Applicants respectfully submit that Chaudhary, Fukushima, Chen, Jang, and Glicksman do not teach or suggest the combination of features recited in claims 1 and 27.

Applicants submit that Chaudhary does not teach or suggest a method of manufacturing a rigid foam board or a rigid foam product that includes incorporating nanoparticle nucleating agents into a polymer melt where the polymer in the polymer melt consists of at least one alkenyl aromatic polymer material and optionally one or more non-alkenyl aromatic polymer as required by claims 1 and 27. Chaudhary teaches foams that include blends of one or more alkenyl aromatic homopolymers, or copolymers of alkenyl aromatic monomers, and/or copolymers of alkenyl aromatic monomers with one or more copolymerizable ethylenically unsaturated comonomers (other than ethylene or linear C₃-C₄ α -olefins) with at least one substantially random interpolymer. (*See, e.g.* column 4, lines 27-33). The interpolymer is derived from ethylene and one or more α -olefin monomers with one or more vinyl or vinylidene aromatic monomers and/or aliphatic or cycloaliphatic vinyl or vinylidene monomers. (*See, e.g.* column 4, line 65 to column 5, line 2). Thus, the polymer melt of Chaudhary includes a blend of alkenyl aromatic homopolymers and/or copolymers *and* an interpolymer.

These teachings of Chaudhary may be contrasted to the claimed methods where the polymer in the polymer melt consists of at least one alkenyl aromatic polymer material and optionally one or more non-alkenyl aromatic polymer. Indeed, the polymer melt of the claimed invention excludes the presence of the interpolymer of Chaudhary, which is formed from ethylene and at least one other monomer. (*See, e.g.* column 4, line 65 to column 5, line 2). Chaudhary specifically requires the presence of the substantially random interpolymer in the polymer melt and teaches that it is the interpolymer that causes an increase in cell size. (*See, e.g.* column 4, lines 27-33 and column 3, lines 40-45). Applicants respectfully submit that there is simply no teaching or suggestion within Chaudhary of the claimed polymer melt. It is respectfully submitted that the addition of Fukushima, Chen, Jang, and/or Glicksman, regardless of their teachings, would not result in the methods of claims 1 and 27 at least because of the specific inclusion of the substantially random interpolymer in the polymer melt of Chaudhary. Accordingly, it is respectfully submitted that claims 1 and 27, and all claims dependent therefrom, are non-obvious and patentable.

Additionally, Applicants submit that there is no motivation for one of skill in the art to arrive at the methods of claims 1 and 27 based on the disclosures of Chaudhary, Fukushima, Chen, Jang, and Glicksman. To establish a *prima facie* case of obviousness, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine

reference teachings, and the prior art reference (or references when combined) must teach or suggest all the claim limitations. (See, e.g., *Manual of Patent Examining Procedure*, Patent Publishing, LLC, Eighth Ed., Rev. 7, August 2008, §2143 citing *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 82 USPQ2d 1385 (2007)).

Applicants respectfully submit that one of skill in the art would have no motivation to arrive at a method of manufacturing a rigid foam board or a rigid foam product where the polymer in the polymer melt consists of at least one alkenyl aromatic polymer material and optionally one or more non-alkenyl aromatic polymer based on the teachings of Chaudhary, Fukushima, Chen, Jan, and Glicksman at least because the polymer melt of Chaudhary requires the inclusion of a substantially random interpolymer derived from ethylene and one or more α -olefin monomers with one or more vinyl or vinylidene aromatic monomers and/or aliphatic or cycloaliphatic vinyl or vinylidene monomers. Applicants respectfully submit that there is simply no teaching or suggestion within Chaudhary of the claimed polymer melt. It is also submitted that the teachings of Fukushima, Chan, Jang, and Glicksman do not add to the Examiner's rejection so as to make claims 1 or 27 unpatentable. Applicants respectfully submit that without some teaching or suggestion, there can be no motivation, and without motivation, there can be no *prima facie* case of obviousness.

In addition, Applicants submit that because Chaudhary, Fukushima, Chen, Jang, and Glicksman do not teach or suggest a method of manufacturing a rigid foam board (claim 1) or a method of manufacturing a rigid foam product (claim 27) that includes incorporating nanoparticle nucleating agents into a polymer melt where the polymer in the polymer melt consists of at least one alkenyl aromatic polymer material and optionally one or more non-alkenyl aromatic polymer, Chaudhary, Fukushima, Chen, Jang, and Glicksman, alone or in any combination, fail to teach all of the claim limitations set forth in claim 1 or claim 27. Therefore, it is respectfully submitted that a *prima facie* case of obviousness has not been established for this additional reason.

With respect to claims 2-8, 10-15, 29-32, and 34-36, Applicants submit that because independent claims 1 and 27 are not taught or suggested by Chaudhary, Fukushima, Chen, Jang, and Glicksman and claims 2-8, 10-15, 29-32, and 34-36 are dependent upon one of claim 1 or claim 27 and contain the same elements as the claim from which they depend, dependent claims 2-8, 10-15, 29-32, and 34-36 are also not taught or suggested by Chaudhary, Fukushima, Chen, Jang, and Glicksman.

In light of the above, Applicants submit that claims 1-8, 10-15, 27, 29-32, and 34-36 are not obvious over Chaudhary in view of Fukushima, Chen, Jang, and Glicksman and respectfully request reconsideration and withdrawal of this rejection.

Rejection of Claims 1-8, 10-15, 27-32, and 34-36 under 35 U.S.C. §103(a)

Claims 1-8, 10-15, 27-32 and 34-36 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,674,916 to Shmidt, *et al.* (“Chaudhary”) in view of Fukushima, *Graphite Nanoplatelets as Multifunctional Reinforcements of Polymer Composites* (“Fukushima”), Chen, *et al.*, *Dispersion of Nanosheets in a Polymer Matrix and the Conducting Property of the Nanocomposites*, (“Chen”) U.S. Patent No. 7,071,258 to Jang, *et al.* (“Jang”) or U.S. Patent No. 5,010,112 to Glicksman, *et al.* (“Glicksman”). The Examiner asserts that Shmidt teaches a process of producing a foam having a cell size of 70 micrometers or less that includes blending molten polystyrene and a blowing agent and extruding the mixture through a die to form the foam product. It is also asserted that Shmidt teaches that the foam employs from about 4 to 10% by weight of an infrared attenuating filler, such as graphite, to enhance the performance of the product. The Examiner admits that Shmidt does not disclose the particle size of the graphite.

In this regard, Fukushima is cited for assertedly teaching a method where graphite nanoplatelets are employed as a replacement of nanoclays. Chen assertedly teaches that graphite in the form of a nanosheet is effective for improving the mechanical properties of the polymer matrix. It is also asserted that Jang teaches that graphite in the form of nano-scaled plates is suited for use in polymeric matrix materials. Further, the Examiner cites Glicksman for assertedly teaching flakes coated with a thin layer/sheet of graphite having a thickness of one or more orders of magnitude less than a micron is effective at improving the properties of a foam material. The Examiner concludes that it would have been obvious to one of skill in the art to utilize the graphite material of any one of Fukushima, Chen, Jang, or Glicksman in the process of Shmidt to reinforce and improve the properties of the final product.

Applicants’ Response

Initially, Applicants submit that claim 28 has been canceled without prejudice, thereby rendering the rejection of this claim moot.

In response to the rejection of the remaining claims, Applicants respectfully direct the Examiner’s attention to independent claims 1 and 27 and submit that claim 1 defines a method of making a rigid foam board and claim 27 defines a method of making a rigid foam

product that are not taught or suggested within Shmidt, Fukushima, Chen, Jang, or Glicksman. Additionally, Applicants respectfully submit that Shmidt, Fukushima, Chen, Jang, and Glicksman do not teach or suggest the combination of features recited in claims 1 and 27.

In particular, Applicants submit that Shmidt does not teach or suggest a method of manufacturing a rigid foam board or a rigid foam product where the foam board or foam product has at least 90% closed cells as required by claims 1 and 27. Indeed, Shmidt specifically teaches an open cell microcellular aromatic polymer foam. (*See, e.g.* the Abstract). Shmidt further teaches that the foam has an open cell content of 70% or more. (*See, e.g.* column 1, lines 50-55 and 59-63, and column 2, lines 21-23). Applicants submit that the open cell content of the foam of Shmidt is vastly different from the claimed foam board and foam product that has a closed cell content of at least 90%. There is absolutely no teaching or suggestion anywhere within Shmidt of a foam product that has a closed cell content of at least 90% as claimed in claims 1 and 27. Indeed, it is respectfully submitted that Shmidt teaches away from the claimed, closed cell foam. In addition, it is respectfully submitted that regardless of the teachings of Fukushima, Chen, Jang, or Glicksman, the combination would not result in the claimed foam board or foam product at least because Shmidt clearly and specifically teaches an open cell content of at least 70%. Accordingly, Applicants respectfully submit that claims 1 and 27, and all claims dependent therefrom, are non-obvious and patentable over Shmidt, Fukushima, Chen, Jang, or Glicksman.

Additionally, Applicants submit that there is no motivation for one of skill in the art to arrive at the methods of claims 1 and 27 based on the disclosures of Shmidt, Fukushima, Chen, Jang, and Glicksman. To establish a *prima facie* case of obviousness, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings, and the prior art reference (or references when combined) must teach or suggest all the claim limitations. (*See, e.g., Manual of Patent Examining Procedure*, Patent Publishing, LLC, Eighth Ed., Rev. 7, August 2008, §2143 citing *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 82 USPQ2d 1385 (2007)).

Applicants respectfully submit that one of skill in the art would have no motivation to arrive at a method of manufacturing a rigid foam board or a rigid foam product where the foam board or foam product has at least 90% closed cells based on the teachings of Shmidt, Fukushima, Chen, Jan, and Glicksman at least because the foam of Shmidt has an open cell

content of at least 70%. Applicants respectfully submit that Shmidt teaches away from the claimed rigid foam board and rigid foam product that have a closed cell content of at least 90%. It is also submitted that the teachings of Fukushima, Chan, Jang, and Glicksman do not add to the Examiner's rejection so as to make claim 1 or claim 27 unpatentable. Applicants respectfully submit that without some teaching or suggestion, there can be no motivation, and without motivation, there can be no *prima facie* case of obviousness.

In addition, Applicants submit that because Shmidt, Fukushima, Chen, Jang, and Glicksman do not teach or suggest a method of manufacturing a rigid foam board (claim 1) or a rigid foam product (claim 27) where the foam board or foam product has at least 90% closed cells, Shmidt, Fukushima, Chen, Jang, and Glicksman, alone or in any combination, fail to teach all of the claim limitations set forth in claim 1 and claim 27. Therefore, it is respectfully submitted that a *prima facie* case of obviousness has not been established for this additional reason.

In addition, Applicants have amended claim 27 to include the features of claim 33, which was not included in this rejection. Accordingly, it is respectfully submitted that claim 27 is non-obvious and patentable for this additional reason.

With respect to claims 2-8, 10-15, 29-32, and 34-36, Applicants submit that because independent claims 1 and 27 are not taught or suggested by Shmidt, Fukushima, Chen, Jang, and Glicksman and claims 2-8, 10-15, 29-32, and 34-36 are dependent upon one of claim 1 or claim 27 and contain the same elements as the claim from which they depend, dependent claims 2-8, 10-15, 29-32, and 34-36 are also not taught or suggested by Shmidt, Fukushima, Chen, Jang, and Glicksman.

In light of the above, Applicants submit that claims 1-8, 10-15, 27, 29-32, and 34-36 are not obvious over Shmidt in view of Fukushima, Chen, Jang, and Glicksman and respectfully request reconsideration and withdrawal of this rejection.

Conclusion

In light of the above, Applicants believe that this application is now in condition for allowance and therefore request favorable consideration.

If any points remain in issue which the Office feels may be best resolved through a personal or telephone interview, the Office is kindly requested to contact the undersigned at the telephone number listed below.

If necessary, the Commissioner is hereby authorized to charge payment or credit any overpayment to Deposit Account No. 50-0568 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

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